U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Gammarus hyalleloides*

COMMON NAME: diminutive amphipod

LEAD REGION: Region 2

INFORMATION CURRENT AS OF: October 2005

STATUS/ACTION:

___ Species assessment - determined species did not meet the definition of endangered or threatened under the Act and, therefore, was not elevated to Candidate status
___ New candidate
_X_ Continuing candidate
  _X_ Non-petitioned
  ___ Petitioned - Date petition received:
    _ 90-day positive - FR date:
    _ 12-month warranted but precluded - FR date:
    _ Did the petition requesting a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:
a. Is listing warranted (if yes, see summary of threats below)? Yes
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? Yes
c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.
We find that the immediate issuance of a proposed rule and timely promulgation of a final rule for this species has been, for the preceding 12 months, and continues to be, precluded by higher priority listing actions (including candidate species with lower LPNs). During the past 12 months, almost our entire national listing budget has been consumed by work on various listing actions to comply with court orders and court-approved settlement agreements, meeting statutory deadlines for petition findings or listing determinations, emergency listing evaluations and determinations, and essential litigation-related, administrative, and program management tasks. We will continue to monitor the status of this species as new information becomes available. This review will determine if a change in status is warranted, including the need to make prompt use of emergency listing procedures. For information on listing actions taken over the past 12 months, see the discussion of "Progress on Revising the Lists," in the current CNOR which can be viewed on our Internet website (http://endangered.fws.gov/).
___ Listing priority change
  Former LP: ___
  New LP: ___
Date when the species first became a Candidate (as currently defined): 5/11/05

___ Candidate removal: Former LP: ___

- ___ A – Taxon is more abundant or widespread than previously believed or not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.
- ___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.
- ___ F – Range is no longer a U.S. territory.
- ___ I – Insufficient information exists on biological vulnerability and threats to support listing.
- ___ M – Taxon mistakenly included in past notice of review.
- ___ N – Taxon does not meet the Act's definition of "species."
- ___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Crustacean, Gammaridae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Texas

CURRENT STATES/ COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Texas, Reeves and Jeff Davis counties

LAND OWNERSHIP: 25% Federal (Phantom Lake Spring – Bureau of Reclamation); 25% State (San Solomon Spring – Balmorhea State Park, Texas Parks and Wildlife Department); 50% private (East Sandia Spring – The Nature Conservancy; Giffin Spring – local landowner). Lands surrounding the spring habitats are all privately owned.

LEAD REGION CONTACT: Susan Jacobsen, 505-248-6641

LEAD FIELD OFFICE CONTACT: Austin Ecological Services Field Office, Nathan Allan, 512-490-0057

BIOLOGICAL INFORMATION

Species Description and Taxonomy: The diminutive amphipod (*Gammarus hyalleloides* Cole) was first collected by W.L. Minckley from Phantom Lake Spring in 1967 and was formally described by Cole (1976). The name comes from the species being considered the smallest of the known North American fresh-water *Gammarus* amphipods. Adults range in size from 5 to 8 mm. Some diagnostic features include more elongate and less setaceous than G. pecos; lacking setae on the posterior margin of the first peduncular segment of antenna 1; coxal plates 1-4 with fewer anteroventral setae, rarely more than a sum of 10 on one side; epimera 2 and 3 armed with spines, usually lacking anterior, ventral, and facial setae; and females without teeth in palmar concavities of gnathopods 1 and 2 (Cole 1976).

This is one species of a related group of amphipods from the Pecos River Basin, referred to as the *Gammarus-pecos* complex (Cole 1985, Lang et al. 2003, Gervasio et al. 2004). In Cole's

(1985) description of these amphipods based on morphological measurements, he considered *G. hyalleloides* to be endemic only to Phantom Lake Spring and amphipods from San Solomon and Diamond Y springs were considered to be *G. pecos* (Cole 1985). However, recent genetic analysis provides strong evidence that the Toyah Basin populations (Phantom Lake, San Solomon, Giffin, and East Sandia springs) form a separate, distinct group from *G. pecos* (Gervasio et al. 2004). Genetic analysis suggests that *G. pecos* occurs only at Diamond Y Spring (Cole and Bousfield 1970) and *G. hyalleloides* and the other Toyah Basin amphipod populations form an unresolved group (Gervasio et al. 2004).

Based on the best available science, we consider the amphipod population at Phantom Lake Spring to be the same species as the other three Toyah Basin populations (San Solomon, Giffin, and East Sandia springs). These populations are being treated as one taxa. However, some genetic differences among these populations were detected, and more detailed phylogenetic analysis may lead to additional species being described from within this group (Gervasio et al. 2004). If future study separates these four populations into more than one taxa, each should still be considered warranted for inclusion as a candidate for listing, because of the high degree of threats to the habitat.

<u>Habitat</u>: The diminutive amphipod only occurs in desert spring outflow channels. The small amphipods occur on substrates, often within interstitial spaces on and underneath rocks and within gravels (Lang et al. 2003), and are most commonly found in microhabitats with flowing water. They are also commonly found in dense stands of submerged vegetation, primarily *Chara* beds (Cole 1976). Because of their affinity for the constant water temperatures, they are most common in the immediate spring outflow channels, usually only a few hundred meters (m) downstream of spring outlets.

Amphipods play important roles in the processing of nutrients in aquatic ecosystems (Gee 1988, Pennak 1989). Amphipods are considered sensitive to changes in aquatic habitat conditions (Covich and Thorpe 1991) and are often considered ecological indicators of ecosystem health (Lackey 1995) and integrity (Callicott 1994). Amphipods from the *G. pecos* complex are considered highly imperiled, suggesting a systemic deterioration of aquatic ecosystems in the desert springs where they occur, based mostly on declining spring flows (Lang et al. 2003).

<u>Historical and Current Range/Distribution</u>: The diminutive amphipod is endemic to the Toyah Basin of the Pecos River drainage of Texas. It is one species of a distinct group of amphipods that are restricted to euryhaline (that is, having a wide range of salinities) desert spring systems in southeast New Mexico and west Texas (Cole 1985). It is thought that these freshwater amphipods are derived from a widespread ancestral marine amphipod that was isolated inland during the recession of the Late Cretaceous sea, about 66 million years ago (Bousfield 1958, Holsinger 1976, Lang et al. 2003). They likely evolved into distinct species during recent dry periods (since the Late Pleistocene, ca. 100,000 years ago) through allopatric speciation following separation and isolation in the remnant aquatic habitats associated with springs (Gervasio et al. 2004). Such divergence has been well-documented for aquatic and terrestrial macroinvertebrate groups within arid ecosystems of western North America (for example, Bowman 1981, Taylor 1987, Metcalf and Smartt 1997, Hershler et al. 1999).

The diminutive amphipod occurs in only four springs in Jeff Davis and Reeves Counties, Texas: Phantom Lake, San Solomon, Giffin, and East Sandia springs (collectively referred to here as the San Solomon Springs System) (Gervasio et al. 2004). These springs are all within about 8 miles (13 km) of each other. There is no available information that the species historic distribution was larger than the present distribution. However, other area springs may have contained the same or similar species, but because these springs have been dry for many decades (Brune 1981), there is no opportunity to determine the potential historic occurrence of amphipods.

Other species of concern share a similar distribution, including the endangered fishes, Comanche Springs pupfish (*Cyprinodon elegans*) (Echelle 1975), Pecos gambusia (*Gambusia pecos*) (Echelle et al. 1989), and two hydrobiid aquatic snails that are candidates for listing, Phantom Cave snail (*Cochliopa texana*) and Phantom springsnail (*Tryonia cheatumi*). Some differences occur in the distribution of these species compared to the amphipod. Pecos gambusia occurs in other spring systems outside the Toyah Basin and Comanche Springs pupfish has not been documented from East Sandia Spring in recent years. Also, the federally threatened Pecos (=Puzzle) sunflower (*Helianthus paradoxus*) occurs only at East Sandia Spring in the Toyah Basin and in other areas of Texas and New Mexico.

<u>Population Estimates/Status</u>: Within its limited range, diminutive amphipod can be very abundant. For example, in May 2001, Lang et al. (2003) estimated mean densities at San Solomon, Giffin, and East Sandia springs of 6833 amphipods per square meter (standard error ±5416), 1167 (±730), and 4625 (±804), repectively. No data is available for Phantom Lake Spring densities, as the amphipod was not found there at the time of these surveys.

THREATS:

A. <u>The present or threatened destruction, modification, or curtailment of its habitat or range</u>.

<u>Water Quantity</u>: The most significant threat to the continued existence of this amphipod is the degradation and eventual loss of spring habitat (flowing water) due to the decline of groundwater levels of the supporting aquifer. The San Solomon Spring System (System) is located in the Toyah Basin at the foothills of the Davis Mountains near Balmorhea, Texas. In addition to being an important habitat for rare aquatic fauna, area springs also an important source of irrigation water for the farming communities in the Toyah Basin. Phantom Lake Spring is in Jeff Davis County, while the other major springs in this system are in Reeves County. The Reeves County Water Improvement District #1 (District) diverts water from the springs using a system of canals to irrigate area fields (Reeves County Water Improvement District #1 2001).

Pumping of the regional aquifer system for agricultural production of crops has resulted in the drying of other springs in this region (Brune 1981). Other springs that have already failed include Comanche Springs, which was once a large surface spring in Fort Stockton, Texas. Prior to the 1950s, this spring flowed at more than 1200 liters per second (lps) (42 cubic-feet per second (cfs)) (Brune 1981) and provided habitat for rare species of fishes and invertebrates, likely including amphipods. The spring ceased flowing by 1962 (Brune 1981). Leon Springs, located about 40 miles east of Balmorhea, was measured at 500 lps (18 cfs) in the 1930s and was also known to contain rare fish, but ceased flowing in the 1950s following significant irrigation pumping (Brune 1981).

The general physiographic setting of the System is that of a largely alluviated, arid, karst terrain. The aridity of the region restricts the available habitat for spring-dependent species and limits the available recharge to replenish and maintain spring flow. Surface waters in the area that provide habitat for the amphipods are exclusively supported by spring flows that discharge from groundwater aquifers. Many of the aquifers in west Texas receive little to no recharge (Scanlon et al. 2001) and are influenced by regional flow patterns (Sharp 2001). Management and conservation of these aquifers is the key for ensuring the continued survival of rare species in the spring habitats (Bowles and Arsuffi 1993). Historically, the springs in the System were likely periodically interconnected as portions of the Toyah Creek watershed. In recent times, man-made structures altered the patterns of spring outflows and stormwater runoff from the watershed.

The base flows from springs of the System are likely discharge points of a regional flow system from aquifers associated with the Salt Basin, west of the Delaware Mountains, and Wildhorse Flat, west of the Apache Mountains, Culberson County (Sharp 2001, Sharp et al. 2003, Texas Water Development Board 2005). The relationships of the supporting aquifers for the springs are not well defined. Studies (White et al. 1938, LaFave and Sharp 1987, Schuster 1997, Sharp et al. 1999) indicate that "base flow" comes from a regional groundwater system, while the springs respond to runoff from the Davis Mountains, sometimes resulting in the flow spikes following rainfall events. Similar water chemistry, water age, and near constant temperatures of about 26^{o}C (79^{o}F) among three of the springs (Phantom Lake, San Solomon, and Giffin) indicate that their waters likely originate from the same source of Cretaceous Limestone (Schuster 1997). East Sandia waters are likely a result of shallower, local groundwater sources (Schuster 1997).

An assessment of the springs near Balmorhea by Sharp (2001) concluded:

> The effects of humans on the Toyah Basin aquifer have been significant. Irrigation pumpage increased rapidly after 1945. Many springs in the area have since ceased to flow (Brune 1981). Irrigation pumpage from the Toyah Basin lowered water-table elevations and created a cone of depression. Thus, pumpage totals altered the regional-flow-system discharge zone from the Pecos River to irrigation wells within the Toyah Basin (LaFave and Sharp 1987, Schuster 1997, Boghici 1997). … The Groundwater Field Methods classes found water-level declines near Balmorhea springs of about 20 ft with respect to the 1932 data (White et al. 1938). Recent declines of pumpage for irrigation because of economic conditions have allowed partial recovery of water levels, but it seems doubtful that predevelopment conditions will be achieved.

Ashworth et al. (1997) provided a brief study to examine the cause of declining spring flows in the Toyah Basin. The conclusion from this study suggested that recent declines in spring flows are more likely to be the result of diminished recharge due to the extended dry period rather than from groundwater pumpage (Ashworth et al. 1997). Although certainly a factor, drought is unlikely the only reason for the declines because the drought of record in the 1950s had no effect on the overall flow trend (Allan 2000, Sharp 2001). The Texas Water Development Board (2005) provided a thorough review of the hydrogeology and the regional flow system for the springs that support this species. The complexity of the aquifer system and the limited availability of data results in a high level of uncertainty about the cause of spring flow declines. However, the report concluded that, "Because of the regional scale of the base flow, slow travel time, and the age of the waters issuing from the spring system, we expect that any substantial pumping on the regional flow system will cause a decline in spring flow in the San Solomon Springs system" (Texas Water Development Board 2005).

Phantom Lake Spring: Phantom Lake Spring is located at the base of the Davis Mountains, about 6.4 kilometers (km) (4 miles (mi)) west of Balmorhea State Park, just over the Reeves County line in Jeff Davis County. The 6.9-hectare (17-acre) site around the spring and cave opening is owned by the U.S. Bureau of Reclamation (Reclamation). The site includes a 120-m (394-feet (ft)) pupfish refuge canal and is surrounded by an outcrop of limestone cliffs. When water was present from the spring, it was an important site for wildlife, especially small mammals, bats, and birds.

Historically, Phantom Lake Spring was a large desert ciénega with a pond of water more than several acres (ac) in size (Hubbs 2001). The spring outflow is at about 1,080 m (3,543 ft) elevation and previously provided ideal habitat for the endemic native aquatic fauna. Flow from Phantom Lake Spring was originally isolated from the other waters in the system, and the spring discharge quickly recharged back underground before reaching Toyah Creek. Modifications to the spring outflow channeled waters into Toyah Creek, west of San Solomon and Giffin springs (White et al. 1938) for use by local landowners and irrigation by the District. Flows from Phantom Lake Spring have been declining since measurements were taken in the 1930s (Brune 1981) and have not been sufficient to support irrigation by the District for many years. During the 1940s the spring outflow was modified into a concrete-lined irrigation ditch so that the total outflow from the spring could be captured and used for irrigation of agriculture lands (Bogener 2003). The native aquatic fauna persisted, though probably in reduced numbers, in the small pool of water at the mouth of the spring (Phantom Cave) and in the irrigation canals downstream.

Phantom Lake Spring has experienced a long term, consistent decline in spring flows. Discharge data have been recorded from the spring six to eight times per year since the 1940s by the U.S. Geological Survey (Schuster 1997). The record shows a steady decline of flows, from greater than 10 cfs in the 1940s to 0 cfs in 2000. The data also show that the spring can have short term flow peaks resulting from local rainfall events in the Davis Mountains (Sharp et al. 1999). These peaks are from fast recharge and discharge, not surface runoff because the spring is not within a drainage basin. However, after each increase, the base flow has returned to the same declining trend within a few months. The exact causes for the decline in flow from Phantom Lake Spring are unknown. Some of the obvious reasons are groundwater pumping of the supporting aquifer and decreased recharge of the aquifer from drought (Sharp et al. 1999, Sharp 2003).

Exploration of Phantom Cave by cave divers has led to additional information about the nature of the spring and its supporting aquifer. Beyond the entrance, the cave is a substantial conduit that transports a large volume of water generally from the northwest to the southeast, consistent with regional flow pattern hypothesis. Over 2,438 m (8,000 ft) of the cave conduit have been mapped so far. In addition, flows have been measured and are in the 0.7 cubic-meters/second (25 cfs) range. The relatively small flow at Phantom Lake Spring is essentially an overflow of a larger flow system underground. Waters from Phantom Lake Spring issue at a higher elevation than other springs in the System, resulting in Phantom Lake Spring being the first to be impacted by declining groundwater levels. This situation was predicted by White et al. (1938).

The pupfish refuge canal was built by Reclamation in 1993 (Young et al. 1993) to increase the available aquatic habitat at Phantom Lake Spring. Winemiller and Anderson (1997) showed that the refuge canal, although it was an artificial habitat, was used by endangered fish species when water was available. Stomach analysis of the pupfish from Phantom showed that the amphipods were a part of the fish's diet (Winemiller and Anderson 1997). The refuge canal was constructed for a design flow down to about 14 lps (0.5 cfs), which at the time of construction was the lowest flow ever recorded out of Phantom Lake Spring. Recent loss of spring flow has eliminated the usefulness of the refuge canal because it is has been dry since the summer of 2000 (Allan 2000).

Phantom Lake Spring ceased flow during the summer of 2000 and has not recovered. All that remains of the spring outflow habitat is a small pool of water, with about 50 m^2 (540 ft^2) of surface area. In May 2001, Reclamation, in cooperation with the U.S. Fish and Wildlife Service (Service), installed an emergency pump to move water from within the cave to the springhead, as a temporary measure to prevent complete drying of the pool. Habitat for the amphipods at Phantom Lake Spring is now limited to this small pool. Despite the fact that Phantom Lake Spring has been drastically altered from its original state, the native aquatic fauna are maintaining minimal populations there. Hubbs (2001) documented changes in water quality and fish community structure at Phantom Lake Spring since natural flows ceased.

Prior to installation of the pumping system in 2001, it was suspected that the diminutive amphipod had been extirpated from Phantom Lake Spring. No records of the amphipods were available after the study by Winemiller and Anderson (1997) had collections of amphipods in pupfish stomachs in 1995. Surveys for amphipods in 1999 to 2001 found no evidence of amphipods (Allan 2000, Lang et al. 2003). In the fall of 2001, the amphipods were rediscovered and are currently locally abundant in the small pool at the cave mouth (Lang et al. 2003).

Another endemic aquatic amphipod may have occurred historically in lateral canals at Phantom Lake Spring (Cole 1976, 1985). This amphipod was only mentioned as a unique "form" and was never actually described as a separate species. The aquatic habitat where this form occurred (downstream and lateral canals that may have had a separate spring source) has been dry for many years and this other amphipod form is now extinct.

San Solomon Spring: San Solomon Spring, in Reeves County, is by far the largest spring in the Balmorhea area (Brune 1981). It provides the water for the swimming pool at Balmorhea State Park and most of the irrigation water for the District. Balmorhea State Park encompasses about 18.6 ha (45.9 ac) southwest of Balmorhea in Reeves County. The park is owned and managed by the Texas Parks and Wildlife Department (TPWD). It was built by the Civilian Conservation Corps in the early 1930s and was opened as a state park in 1968. The entire spring head was converted into a concrete-lined swimming pool. The outflow from the pool is completely contained in concrete irrigation channels.

In 1996, TPWD created the San Solomon Ciénega which uses some spring flow to recreate more natural aquatic habitats for the benefit of the endangered fishes in the Park (McCorkle et al. 1998, Garrett 2003). It was designed to resemble and function like the original ciénega for the native aquatic fauna. The District and the local community it represents agreed to provide the essential water needed to create a secure environment for the endangered species. The main purpose of this restoration project was to recreate vital habitat, not only for the two endangered fishes, but for other aquatic, terrestrial, and wetland-adapted organisms as well (McCorkle et al. 1998, Garrett 2003).

The artesian spring issues from the lower Cretaceous limestones at an elevation of 1,020 m (3,346 ft). Although long-term data are scarce, San Solomon Spring flows have declined somewhat over the history of record, but not as much as Phantom Lake Spring (Schuster 1997, Sharp et al. 1999). Some recent declines in overall flow have likely occurred due to drought conditions and declining aquifer levels (Sharp 2003). San Solomon Spring discharges are usually in the 560 to 850 lps (20 to 30 cfs) range (Ashworth et al. 1997, Schuster 1997) and are consistent with the theory that the water bypassing Phantom Lake Spring discharges at San Solomon Spring.

Giffin Spring: This spring is located less than 1.6 km (one mi) west, across State Highway 17, from Balmorhea State Park. Access is restricted because the spring is on private property. Brune (1981) documented a gradual decline in flow from Giffin Spring between the 1930s and 1970s, but surprisingly the discharge has remained near constant, within outflow of about 85 to 115 lps (3 to 4 cfs) in recent times (Ashworth et al. 1997). The outflow channel has been modified (dammed and channelized) to accommodate irrigation for downstream canals.

East Sandia Spring: East Sandia Spring is located approximately 3.2 km (2 mi) east of Balmorhea near the community of Brogado. The springs are included in a 97-hectare (240-acre) preserve owned and managed by The Nature Conservancy (TNC) (Karges 2003). A significant sacaton grassland is associated with the habitat included on the site.

Flows from East Sandia Spring are likely from a shallow groundwater source as water chemistry differences indicate it is not directly connected with other Toyah Basin springs (San Solomon Spring, Phantom Lake Spring, Giffin Spring) in the nearby area (LaFave and Sharp 1987; Schuster 1997). East Sandia Spring discharges at an elevation of 977 meters (3,224 feet) from alluvial sand and gravel (Schuster 1997). Brune (1981) noted that flows from Sandia Springs were declining. East Sandia may be very susceptible to over pumping in the area of the local aquifer that supports the spring. Measured discharges in 1995 and 1996 ranged from 12.7 to 115 lps (0.45 to 4.07 cfs) (Schuster 1997). The small outflow channel from East Sandia Spring has not been significantly modified and water flows into the District irrigation system about 100 to 200 meters (328 to 656 feet) after surfacing. West Sandia Spring also occurrs on the TNC preserve, but it ceased flowing in the past 10 years (Schuster 1997). The presence of rare species there is not likely.

In the summer of 2000, East Sandia Spring was surveyed for aquatic macroinvertebrates for the first time. A healthy abundance and diversity of amphipods and other macroinvertebrates were present in the spring head and small outflow channel (Lang et al. 2003). The entire available habitat is estimated at less than 150 m (492 ft) in length, and usually 1 m (3 ft) wide or less.

Interestingly, another amphipod, *Hyalella* sp., also occurs at East Sandia Spring, but is absent from the other Toyah Basin springs. This amphipod is considered common in west Texas and related to the ubiquitous *Hyalella azteca* (Duan et al. 1997, 2000, Lang et al. 2003).

Irrigation Canals: The District maintains an extensive system of over 97 km (60 mi) of irrigation canals that provide minimal aquatic habitat for the native species. Most of the canals are concrete-lined with high velocities and little natural substrate available. Many of the canals are regularly dewatered as part of the normal District operations for water management.

<u>Habitat Quality</u>: Another threat to amphipod habitat is the potential degradation of water quality from point and nonpoint pollutant sources. This can occur either directly into surface water or indirectly through contamination of groundwater that discharges into spring run habitats used by the amphipod. The primary threat for contamination comes from herbicide and pesticide use in nearby agricultural areas.

The natural ciénega habitats of the Balmorhea area have been mostly altered over time to accommodate agricultural irrigation. Most significant was the draining of wetland areas and the modification of spring outlets for development of human use of the water resources. Although the physical condition of the areas has changed dramatically over time from human actions, at least a portion of the native biota remain. Three of the four known occurrences of the species are in degraded habitats (exception is East Sandia Spring) because the natural conditions of the springs have been substantially modified for human use. Any additional modifications to the spring flow habitats will further threaten the species.

B. <u>Overutilization for commercial, recreational, scientific, or educational purposes</u>. Not known to be a factor threatening the diminutive amphipod.

C. <u>Disease or predation</u>. Not known to be a factor threatening the diminutive amphipod.

D. <u>The inadequacy of existing regulatory mechanisms</u>. Texas State law provides no protection for these invertebrate species. There is no existing Federal, State, or local regulatory mechanisms providing protection for these species. The amphipod is afforded some protection indirectly due to the presence of two fishes (Comanche Springs pupfish and Pecos gambusia) listed as endangered, by state and Federal governments, that occupy similar habitats. However, the amphipod may be more sensitive to changes in water quality or other habitat changes than the fish and are likely more directly threatened by the presence of the exotic *Melanoides* snail, than the endangered fish.

Some protection for the habitat of this species is provided with the ownership of the springs by Federal (Phantom Lake) and State (San Solomon) agencies, and by TNC (East Sandia). However, this land ownership provides no protection from the main threat to this species—the loss of necessary groundwater levels to ensure adequate spring flows. Texas groundwater resources are under the "Rule of Capture," which provides little opportunity for regulation of pumping or management of groundwater resources (Potter 2004). Local underground water districts are the method for groundwater management in Texas. Although there are three groundwater districts in the area that could manage groundwater to protect spring flows, generally groundwater districts will not limit groundwater use to allow for conservation of surface water flows (Booth and Richard-Crow 2004, Caroom and Maxwell 2004).

E. Other natural or manmade factors affecting its continued existence. Within the last 10 years, an exotic snail, *Melanoides* sp., has become established in Phantom Lake Spring (McDermott 2000). The species has been at San Solomon Spring (and presumably Giffin) since at least the 1960s, but is not found in East Sandia Spring (McDermott 2000). In many locations at San Solomon Spring, this exotic snail essentially is the substrate in the small stream channel. The effects of this introduction are not known. However, this exotic snail is likely competing with the native macroinvertebrates for space and resources. Other changes to the ecosystem from the dominance of this species are likely to occur and could have detrimental effects to the native invertebrate community.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED: The Service has had a long and active partnership with the Reeves County Water Improvement District #1, the TPWD, TNC, Reclamation and others, in conservation of the endangered fishes that occur in the springs and irrigation system in the Balmorhea area of Reeves and Jeff Davis counties. Texas Parks and Wildlife Department owns and manages Balmorhea State Park, not only for the benefit of visitors, but also for the conservation of the rare and protected aquatic species. The San Solomon Ciénega project by TPWD, the District, and a host of other cooperators was a significant step in conservation of the area's aquatic biota (McCorkle et al. 1998). Texas Parks and Wildlife Department provides some management assistance to the Reclamation for maintenance of the property at Phantom Lake Spring.

The Service has been supporting (through funding and technical assistance) ongoing research on taxonomy and phylogeny of amphipods in west Texas, which provided much of the recent biological information on which this assessment is based. In addition, the Service has been working with TPWD and Reclamation to maintain the aquatic habitat at Phantom Lake Spring through the installation and maintenance of a pumping system there. Section 6 funds are currently being used to upgrade this pumping system to continue this project.

The Service also funded through section 6 to the Texas Water Development Board (TWDB) a regional groundwater study to investigate the source waters of the area springs and determine the causes for declines at Phantom Lake Spring. The final report was completed by the TWDB in May 2005. While the information was very helpful, there were no conclusive results that suggested the cause of the decline in spring flow was directly related to human activities.

SUMMARY OF THREATS: The primary threat to this species is the loss of surface flows due to declining groundwater levels from drought and pumping for agricultural production. Although much of the land immediately surrounding their habitat is owned and managed by TNC, Reclamation, and TPWD, the water needed to maintain their habitat has declined due to a reduction in spring flows, possibly as a result of private groundwater pumping in areas beyond that controlled by these landowners. As an example, Phantom Lake Spring, one of the sites of occurrence, has already ceased flowing and aquatic habitat is supported only by a pumping system.

For species that are being removed from candidate status:
____Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions (PECE)?

LISTING PRIORITY:

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	**Imminent**	Monotypic genus	1
		Species	2*****
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	Imminent	Monotypic genus	7
		Species	8
		Subspecies/population	9
	Non-imminent	Monotypic genus	10
		Species	11
		Subspecies/population	12

Rationale for listing priority number:

Magnitude: All four known sites of occurrence face the threat of loss of spring flow. Threats of spring flow loss will result in complete habitat loss and permanent elimination of entire populations of the species.

Imminence: Drying of Phantom Lake Spring is happening now and will likely extirpate this population in the near future. Declining spring flows in San Solomon Spring is also becoming evident and will impact that spring site as well within the foreseeable future.

__X__ Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed? Yes.

Is Emergency Listing Warranted? Emergency listing of the diminutive amphipod is not warranted at this time. Because the amphipod is sympatric with the two endangered fishes, it benefits from any conservation actions that have been and are being undertaken to recover the fishes. In addition the nature of the main threat of spring flow loss is not a straightforward enforcement action under the Endangered Species Act, and, therefore, emergency listing of the diminutive amphipod is not likely to afford them immediate protection that would either alleviate the threats or prevent extinction.

DESCRIPTION OF MONITORING: Since the recent phylogenetic study of the amphipods began in about 2000, collections of amphipods form the Toyah Basin have been made irregularly on several occasions. Since the diminutive amphipod reoccurred at Phantom Lake Spring in 2001, Service personnel have monitored the spring habitat (maintained by a pumping system) and confirmed presence of the amphipod several times per year. Spring habitats are generally monitored by TPWD and TNC at San Solomon and East Sandia springs, respectively. Flows from San Solomon and Giffin springs are monitored by U.S. Geological Survey, Reclamation, and the District on a continual basis.

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: Texas Parks and Wildlife Department

Indicate which State(s) did not provide any information or comments: NA

LITERATURE CITED

Allan, N. L. 2000. Deterioration of Phantom Lake Spring, Jeff Davis County, Texas. Proceedings of the Desert Fishes Council 32:50-51.

Ashworth, J. B., D. B. Coker, and W. Tschirhart. 1997. Evaluation of diminished spring flows in the Toyah Creek Valley, Texas. Open File Report 97-03. Texas Water Development Board, Austin. 12 pp.

Boghici, R. 1997. Hydrogeological investigations at Diamond Y Springs and surrounding area, Pecos County, Texas. Unpublished Master's Thesis, University of Texas at Austin. 120 pp.

Bowman, T.E. 1981. *Thermosphaeroma milleri* and *T. smithi*, new sphaeromatid isopod crustaceans from hot springs in Chihuahua, Mexico, with a review of the genus. Journal of Crustacean Biology 1:105-122.

Bogener, S. 1993. Balmorhea Project (Second Draft). Research on Historic Reclamation Projects, U.S. Bureau of Reclamation History Program, Denver, Colorado. Accessed November 2003 online at http://www.usbr.gov/dataweb/html/balmorhe.html.

Booth, M.J. and R. Richard-Crow. 2004. Regulatory dance: Rule of Capture and Chapter 36 District perspective. Pages 19-40, *in* W.F. Mullican, III, and Suzanne Schwartz, eds. 100 years of Rule of Capture: from East to groundwater management. Texas Water Development Board, Austin, Texas. Report 361.

Bousfield, E. L. 1958. Fresh-water amphipod crustaceans of glaciated North America. The Canadian Field-Naturalist 72:55-113.

Bowles, D. E. and T. L. Arsuffi. 1993. Karst aquatic ecosystems of the Edwards Plateau region of central Texas, USA: a consideration of their importance, threats to their existence, and effort for their conservation. Aquatic Conservation of Marine and Freshwater Ecosystems 3:317-329.

Brune, G. 1981. Springs of Texas. Branch-Smith, Inc. Fort Worth, Texas.

Callicott, J. B. 1994. A brief history of American conservation philosophy. Pages 10-14, *in* Wallace W. Covington and Leonard F. DeBano, eds. Biodiversity and management of the Madrean Archipelago: the sky islands of southwestern United States and northwestern Mexico. U. S. Forest Service, Rocky Mountain Forest and Range Experiment Station. General Technical Report RM-GTR-264.

Caroom, D.G. S.M. Maxwell. 2004. The Rule of Capture – "If it ain't broke…" Pages 41-61, *in* W.F. Mullican, III, and Suzanne Schwartz, eds. 100 years of Rule of Capture: from East to groundwater management. Texas Water Development Board, Austin, Texas. Report 361.

Cole, G. A. 1976. A new amphipod crustacean, *Gammarus hyalelloides* n. sp., from Texas. Transactions of the American Microscopical Society 89:80-85.

Cole, G. A. 1985. Analysis of the *Gammarus-pecos* complex (Crustacea: Amphipoda) in Texas and New Mexico, USA. Journal of the Arizona-Nevada Academy of Science 20:93-103.

Cole, G. A. and E. L. Bousfield. 1970. A new freshwater Gammarus (Crustacea: Amphipoda) from western Texas. American Midland Naturalist 83:89-95.

Covich, A. P. and J. H. Thorp. 1991. Crustacea: introduction and Peracarida. Pages 665-689, *in* J. H. Thorp and A. P. Covich, eds. Ecology and Classification of North American Freshwater Invertebrates. Academic Press, Inc., San Diego, California.

Duan, Y., S. I. Guttman, and J. T. Oris. 1997. Genetic differentiation among laboratory populations of Hyalella azteca: implications for toxicology. Environmental Toxicology and Chemistry 16:691-695.

Duan, Y., S. I. Guttman, J. T. Oris, and A. J. Bailer. 2000. Genetic structure and relationships among populations of Hyalella azteca and H. montezuma (Crustacea: Amphipoda). Journal of the North American Benthological Society 19:308-320.

Echelle, A. A. 1975. A multivariate analysis of variation in an endangered fish, *Cyprinodon elegans*, with an assessment of populational status. Texas Journal of Science 26:529-538.

Echelle, A. A., A. F. Echelle and D. R. Edds. 1989. Conservation genetics of a spring-dwelling desert fish, the Pecos gambusia (*Gambusia nobilis*, Poeciliidae). Conservation Biology 3:159-169.

Garrett, G.P. 2003. Innovative approaches to recover endangered species. Pages 151-160, i*n* G.P. Garrett and N.L. Allan, eds. Aquatic fauna of the northern Chihuahuan Desert. Museum of Texas Tech University, Special Publications 46.

Gee, J. H. 1988. Population dynamics and morphometrics of *Gammarus pulex* L.: evidence of seasonal food limitations in a freshwater detritivore. Freshwater Biology 19:333-343.

Gervasio, V., D. J. Berg, B. K. Lang, N. L. Allan, and S.I. Guttman. 2004. Genetic diversity in the *Gammarus pecos* species complex: implications for conservation and regional biogeography in the Chihuahuan Desert. Limnology and Oceanography 49:520-531.

Hershler, R., H. P. Liu, and M. Mulvey. 1999. Phylogenetic relationships within the aquatic snail genus *Tryonia*: implications for biogeography of the North American Southwest. Molecular Phylogenetics and Evolution 13:377-391.

Holsinger, J. R. 1967. Systematics, speciation, and distribution of the subterranean amphipod Genus *Stygonectes* (Gammaridae). United States National Museum Bulletin 259. 172 pp.

Holsinger, J. R. and D. Culver. 1970. Morphological variation in *Gammarus minimus* (Amphipoda, Gammaridae) with emphasis on subterranean forms. Postilla, No. 146.

Hubbs. C. 1995. Springs and spring runs as unique aquatic systems. Copeia 1995:989-991.

Hubbs. C. 2001. Environmental correlates to the abundance of spring-adapted versus stream-adapted fishes. Texas Journal of Science 53:299-326.

Karges, J. 2003. Aquatic conservation and The Nature Conservancy in West Texas. Pages 151-150, i*n* G.P. Garrett and N.L. Allan, eds. Aquatic fauna of the northern Chihuahuan Desert. Museum of Texas Tech University, Special Publications 46.

Lackey, R. T. 1995. Ecosystem health, biological diversity, and sustainable development: research that makes a difference. Renewable Resources Journal, Summer 1995:8-13.

LaFave, J.I. and J.M. Sharp. 1987. Origins of groundwater discharging at the Springs of Balmorhea. West Texas Geological Society Bulletin 26:5-14.

Lang, W. B. 1937. The Permian formations of the Pecos Valley of New Mexico and Texas. Bulletin of the American Association of Petroleum Geologist 216:833-898.

Lang, B. K., V. Gervasio, D. J. Berg, S. I. Guttman, N. L. Allan, M. E. Gordon, and G. Warrick. 2003. Gammarid amphipods of northern Chihuahuan Desert spring systems: an imperiled fauna. Pages 47-57, *in* Aquatic Fauna of the Northern Chihuahuan Desert, G. P. Garrett and N. L. Allan, eds. Museum of Texas Tech University. Special Publications 46.

McCorkle, R., G. Garrett and D. Riskind. 1998. An aquatic phoenix rises. Texas Parks and Wildlife Magazine, February 1998:36-43.

McDermott, K. 2000. Distribution and infection relationships of an undescribed digenetic Trematode, its exotic intermediate host, and endangered fishes in springs of west Texas. Unpublished Master's Thesis, Southwest Texas State University, San Marcos, Texas. 26+ pp.

Metcalf, A. L. and R. A. Smartt. 1997. Land snails of New Mexico: a systematic review. Page169, *in* A. L. Metcalf and R. A. Smartt, eds. Land Snails of New Mexico. New Mexico Museum of Natural History and Science Bulletin 10, Albuquerque, New Mexico, 145 pp.

Pennak, R. W. 1989. Fresh-water invertebrates of the United States: Protozoa to Mollusca. 3rd edition. John Wiley & Sons, Inc., New York, New York. 628 pp.

Potter, III, Harry Grant. 2004. History and evolution of the Rule of Capture. Pages 1-9, *in* W.F. Mullican, III, and Suzanne Schwartz, eds. 100 years of Rule of Capture: from East to groundwater management. Texas Water Development Board, Austin, Texas. Report 361.

Reeves County Water Improvement District #1. 2001. Balmorhea Project, water management and conservation plan, drought contingency plan. January 2001, Balmorhea, Texas.

Scanlon, B.R., B.K. Darling, and W.F. Mulican III. 2001. Evaluation of groundwater recharge in basins in Trans-Pecos Texas. Pages 26-40, *in* R.E. Mace, W.F. Mullican, III, and E.S. Angle, eds. Aquifers of West Texas. Texas Water Development Board, Austin, Texas, Report 356.

Schuster, S. K. 1997. Hydrogeology and local recharge analysis in the Toyah Basin Aquifer. Unpublished Master's Thesis, University of Texas at Austin. 130 pp.

Sharp, J.M., Jr. 2001. Regional groundwater flow systems in Trans-Pecos Texas. Pages 41-55, *in* R.E. Mace, W.F. Mullican, III, and E.S. Angle, eds. Aquifers of West Texas. Texas Water Development Board, Austin, Texas, Report 356.

Sharp, J.M., Jr., R. Boghici, and M.M. Uliana. 2003. Groundwater systems feeding the springs of West Texas. Pages 1-12, *in* G.P. Garrett and N.L. Allan, eds. Aquatic fauna of the northern Chihuahuan Desert. Museum of Texas Tech University, Special Publications 46.

Sharp, J. M., Jr., Uliana, M.M., and R. Boghici. 1999. Fracture controls on regional groundwater flow in a semiarid environment and implications for long-term maintenance of spring flows. Water 99 Joint Congress, Institute of Engineers, Brisbane, Australia, 2:1212-1217.

Texas Parks and Wildlife Department. 1999. Balmorhea State Park Resources Management Plan. Approved January 1999. Austin, Texas.

Texas Water Development Board. 2005. Diminished spring flows in the San Solomon Springs System, Trans-Pecos, Texas. Report to the Texas Parks and Wildlife Department.

Section 6 Endangered Species Grant Number WER69, Study Number 84312. Submitted May 2005. 121 +IV pp.

Winemiller, K. O. and A. A. Anderson. 1997. Response of endangered desert fish populations to a constructed refuge. Restoration Ecology, 5:204-213.

White, W., H. Gale and S. Nye. 1938. Ground-water resources of the Balmorhea area in western Texas. Texas Water Development Bd, Misc. Publ., No. 11.

Young, D.A., K.J. Fritz, G.P. Garrett, and C. Hubbs. 1993. Status review of construction, native species introductions, and operation of an endangered species refugium channel, Phantom Lake Spring, Texas. Proceedings of the Desert Fishes Council 25:22-25.

APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: /s/ Rich McDonald 11/17/2005
Acting Regional Director, Fish and Wildlife Service Date

Concur: ______________________________
Director, Fish and Wildlife Service Date

Do not concur: ______________________________
Director, Fish and Wildlife Service Date

Date of annual review: October 13, 2005
Conducted by: Nathan Allan